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The many phases and faces of the Semantic Spider

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Introduction

The semantic web is the concept of an internet where all data is stored in machine-readable formats, facilitating machine reasoning and encoding meaning (Berners-Lee, Hendler and Lassila, 2001); offering many new possibilities to explore and reason across heterogeneous data sources and types. This paper tells a story about a hybrid object known as the ‘Semantic Spider’ that was born out of need to illustrate the concept of semantic web within a large and interdisciplinary research and development project, Ensemble. The overall aim of this project is to research the potential of semantic technologies to enhance case based learning in higher education (www.ensemble.ac.uk). The project began in October 2008; from the outset it has been participatory in the nature of its research and development processes, seeking to research both the technology and the pedagogy it might become embedded within. It has focused upon educational settings where “complexity, contestation or rapid change makes some kind of case based learning the pedagogy of choice” (Tscholl, Tracy and Carmichael, 2009); so far, the project has worked with practitioners in a diverse range of academic settings, including Archaeology, Plant Science, Engineering, Business, Journalism, Dance, Education Studies, Geography and Maritime Operations and Management. The project team is interdisciplinary in the sense that it brings together individuals with broadly Computer Science or Education backgrounds, (though these groupings are not

homogenous; Rimpilainen, 2010); the resulting ‘interdiscipline’ of the team must then engage with the great diversity of academic partner disciplines¹. With such a diversity of backgrounds and arguably little common ground, communication and understanding of the core concepts which underpin the project is key.

One such key concept within the project is the semantic web. Many of the individuals involved in the project, within both the team and the academic settings, were not aware of the concept of the ‘semantic web’ (Berners-Lee, 1998) prior to their involvement in the project. In communicating what the semantic web and the semantic technologies are about, it is often easier to show and discuss a diagram rather than merely explain. In the beginning a number of different diagrams were deployed to help in that task, but in time a particular type of diagram, informally known within the team as the ‘Semantic Spider’, became the most commonly used version. What interested us² in studying this conceptual-material-human hybrid more closely was its frequent appearances in different presentations, the evident changes in its appearance and the way it was being discussed in different contexts. Why was the Spider changing, and how? Was it because the technology was changing, or its use, or because of the needs of the audience it was being shown to? These were the initial questions we set out to answer.

In order to address these questions, we will draw upon the archive of files in the projects’ virtual research environment and interviews with the projects’ core team members as data sources. We will first trace the visual and conceptual history of diagrams used to represent semantic technologies within the project (of which the Spider is one example) and evolution of the Spider through digital artifacts relating to the project. Having established an idea of what it ‘is’ and broadly how it has come

¹ Note to readers: We understand our interdisciplinary research team to be a heterogeneous socio-material network or an assemblage. In true network fashion, the disciplinary divisions are blurry within our team, with many members sporting expertise in both ‘Education’ and ‘Computer Sciences’, as well as many other fields. Despite wishing to enforce the ‘network’ idea of the project, for simplicity’s sake we will be referring as ‘Computer Scientists’ to those who work primarily with technology, and as ‘Educational’ or ‘Social Scientists’ to those who primarily do not, or who, despite their expertise, have not had a hand in creating the Semantic Spider.

² The authors of this paper are outside of the actual research activity taking place, yet very much involved with the project. KJ works as the project administrator, but has a far wider work-remit than what her title would assume, including technology development; SR is a PhD student linked to the project, studying the research practices of the team. The ‘Spider’ emerged as a point of interest both from having personally ‘experienced’ the Spider-in-action and from observing the varying impact it was having on the work of the other team members.

to be, we then explore (via the interviews) the core team³ members' perceptions of its purpose and functions in different contexts. The picture which emerges from this analysis indicates that the Spider may be characterized as a 'practice-negotiating artifact' and the story of the diagram exemplifies the multiplicity of a research project and its practices.

Background – the Semantic web and diagrams

First described in 1998 by Tim Berners-Lee (Berners-Lee, 1998) and popularized by his 2001 Scientific American article (Berners-Lee, Hendler and Lassila, 2001), the 'semantic web' is an abstract concept and can be difficult to comprehend. For several years after this it was the preserve of computer scientists, but in recent years it has become increasingly mainstream, although it is not yet common parlance in the same way that other internet paradigms have become (such as 'web 1.0' and 'web 2.0' for example; 'web 3.0' is used by some as shorthand for the semantic web, but it is not as pervasive as the first two, at present).

In its journey from initial conception to the highly developed field of the semantic web today, many have sought to explain this concept (the semantic web) to others and facilitate discussion by using diagrams to represent it. This was also important to the Ensemble project, right from the outset. Initially the project used 'historical' representations (created and published by others, prior to and independent from the project) to illustrate the concept, as a starting point for a shared understanding of, and conversations about, the semantic web and semantic technologies. The diagram literally displays the components which are needed – databases, conversion tools, semantic repositories, visualization tools – to create applied semantic technologies, and the ways in which the components interact. Indirectly, this confers a sense of what the semantic web is about. Note that the term 'semantic web' is generally applied to the broad vision of a machine-readable world wide web; the term 'semantic technologies' may be applied to smaller-scale applications which borrow technologies or principles from this vision, such as the integration of heterogeneous data sources, advanced search tools, representations and visualisations of data, or collaborative functions (Carmichael and Garcia Martinez, 2009). A level of understanding of the former is necessary to understand the latter.

³ The team as a whole is large, with 16 members based across six UK universities with some members further a field in the US and Australia. The core team consists of six full-time researchers including the project administrator.

As we are discussing a diagram, it is in its nature to be easier explained visually than verbally, so let us introduce the Semantic Spider. The version of the diagram which was first used in public is shown below in Figure 1.

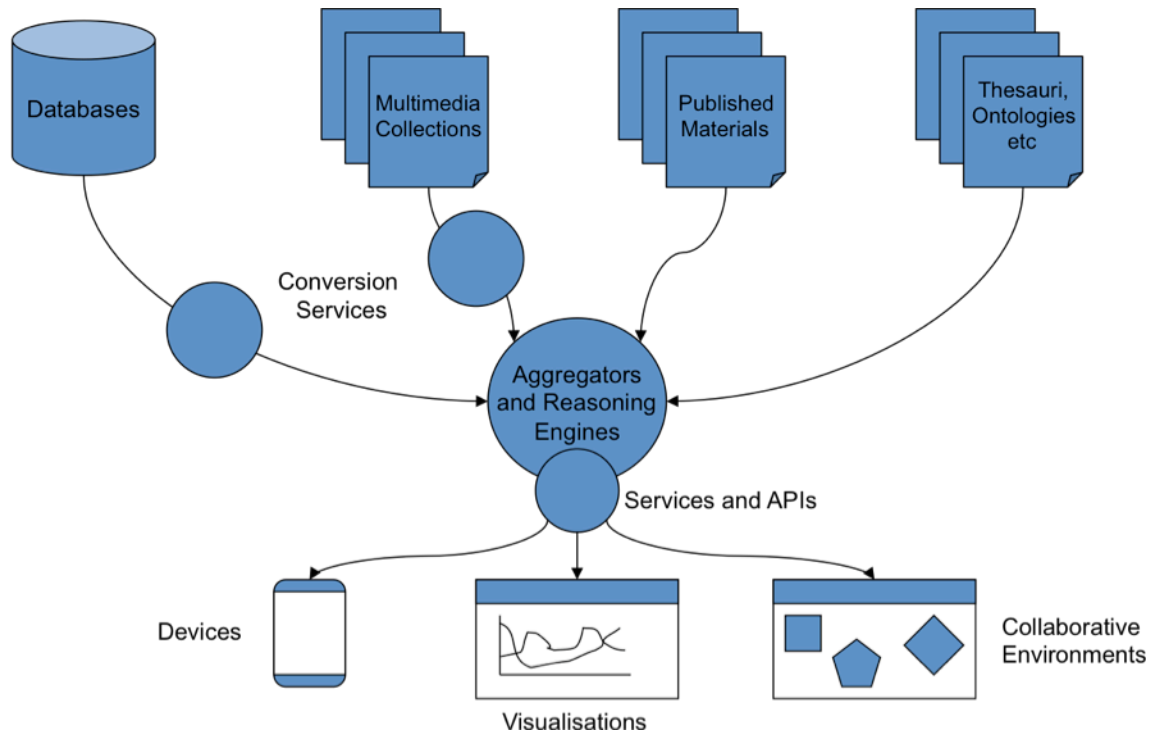


Figure 1: The Semantic Spider diagram, in the format that was first used in public.

Methodological note

The initial point of interest with the Spider was the changes we observed both in its form and its use. What was the nature of this object, why did it keep changing and how did the different team members use it? The Spider is not the only diagram deployed in the task of explaining the semantic web, a number of others had been used too. In order to find answers to these questions we first set out to trace the different versions of the diagrams used for depicting the semantic web or the semantic technologies. The Ensemble team uses a (Sakai) Virtual Research Environment (VRE) for supporting the collaborative research activities of its distributed team. This is a password protected online workspace, which enables the team members to access shared resources as well as a set of tools that support the work of the team. These include e.g. a file store, a co-authoring tool wiki, a chat room etc. (for more info see e.g. Carmichael et al., 2006). The file store contains a wide

range of different types of digital files used or created by the project, including research data, presentations, papers, and photographs of more ephemeral objects (such as drawings on whiteboards). We began by looking through the file store for instances of diagrams depicting the semantic web or semantic technologies, and noting which version of the diagram had been used and when the file had been created. In doing this, it quickly became apparent that the Spider diagram seemed to be an object in flux. Although at any given point in time there is usually a 'latest version' of the Spider, it is rarely stabilized for long, and seemed to be doing very different things as part of different contexts. Furthermore, while we found the 'earliest' stored version of the Spider in the file store, this turned out not to be the 'original' version. Where was the original of this diagram?

In addition to tracing the different versions of the diagrams used over time, we also interviewed all the 'core' team full-time researchers about their experiences and understandings of the diagrams, with a focus on the Semantic Spider. We asked them about how it came to be, or when they first encountered it, how they saw its nature and role as part of the project work, what importance it was to them, whether they used it in their own work, how and why. The interviews were then transcribed and emergent themes examined in relation to each other and the diagrams. In addition to these, we have transcribed sections of team meeting recordings where the 'Spider' has been discussed, and had informal discussion with the team members about it.

In our treatment of these data, we have drawn upon a strand of Actor Network Theory or Material Semiotics writings, most notably Annemarie Mol, Susan Leigh Star and James Griesemer.

Depicting the Semantic Web

Diagrams are commonly used to help explain complex systems, especially in the computer sciences (for example, see e.g. http://commons.wikimedia.org/wiki/Category:Computer_science_diagrams).

During its life, the project has used various diagrams to communicate the concepts of the semantic web or semantic technologies to different internal or external audiences. All the different versions of these diagrams used to communicate aspects of the semantic web are found in the VRE are shown below in Figure 2.

The diagrams could be roughly divided into five main families (see Table 1), all of which (except for the semantic spider) were used at the beginning of the project, mainly to familiarize the interdisciplinary research team with the topic. The 'linked data' model has not been reused, nor has the 'web 1.0 – 2.0 – 3.0' diagram, although a few weeks in to the project one team member created their own hybrid of this and the 'URI model' diagram, the hybrid continues to be used infrequently. The 'layer cake' and variants of it have persisted throughout the project. The semantic spider was introduced three months into the project, and appears to 'outcompete' some of the other diagrams. After an initial profusion of co-opted diagrams, the layer cake (created independent from and preceding the project) and the Semantic spider (created within and by the project) have been the ones used most frequently throughout the course of the project so far.

It may be notable that these diagrams are found largely in collections of Powerpoint slides, intended to be shown as part of an oral presentation. The diagrams are also very frequently coupled with a preceding slide offering a text-based explanation or description of the semantic web. These texts also travel as unchanged objects between different presentations in the same way as diagrams (or aspects of diagrams) do. The collection also shows a photograph of a white board depicting a hand drawn diagram. This – drawing on white-boards, e.g. at meetings, and keeping the photograph – is a common practice within the team, as is the practice of drawing of diagrams itself: most of these diagram versions are outputs, made with a particular purpose in mind. Furthermore, the diagrams are not all just static pictures. As the project develops, the Spider moves first to a html format, and later, is created by using a semantic tool, an Exhibit (Huynh, Karger and Miller, 2007; www.simile-widgets.org/exhibit/), which makes it richer and more interactive, incorporating data sources and technology demonstrators, instead of just showing static boxed pointers to these.

While the Spider diagram has taken on different appearances over the past 18 months, some key characteristics have remained constant, including: three component layers (data sources, aggregation, output), the 'network of nodes' appearance, and directionality (from top to bottom, the bottom showing the 'end product' or tool, the thing that will then be used more widely and for educational purposes).

<p>a) Current Web b) Semantic Web</p>	<p>The URI Model (Koivunen and Miller, 2001)</p> <p>This diagram originated in an early position paper on the semantic web by the W3C. It was difficult to locate; despite the authority of the source, it does not appear to have been widely taken up. It emphasizes that the difference between the semantic web and the existing web is that meaning can be conferred through hyperlinks.</p>
	<p>The Layer Cake (Berners-Lee, 2000)</p> <p>Possibly the most famous diagram about the semantic web. This was first used by Tim Berners-Lee in one of his early presentations outlining his vision for a semantic web. It outlines the technical challenges that must be met in order to facilitate his vision. It has been used by others and changed as technical challenges have been met; “the stack is still evolving as the layers are concretized” http://en.wikipedia.org/wiki/Semantic_Web_Stack</p>
<p>Web 1.0 Web 2.0 The Semantic Web</p> <p>C/P = Consumer/Producer</p>	<p>‘Web 1.0’ - ‘Web 2.0’ - ‘Web 3.0’ Progression (Coffey, 2007)</p> <p>This diagram was first published in a 2007 blog post. The author describes it as an “attempt at a Plain English explanation of this woolly and unfortunately named concept, hopefully in a way that even my mum would understand”. It describes the semantic web – ‘web 3.0’ – as a progression from web 1.0 and 2.0. These are poorly defined terms, and not necessarily a linear progression (e.g. you could take a simple website and transform it with semantic principles without being social or user-generated about it at all).</p>

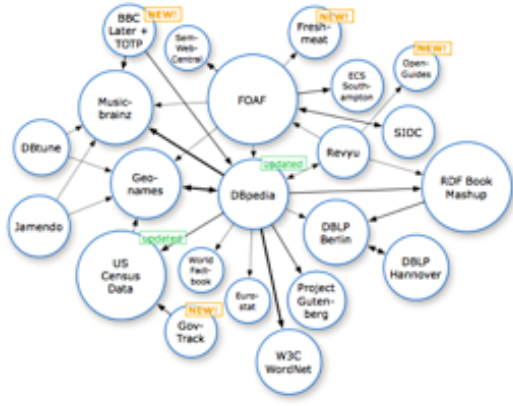
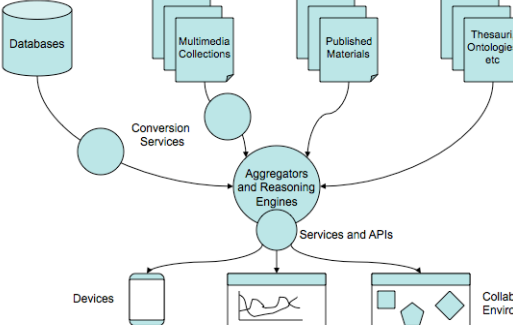
	<p>Linked Data (http://linkeddata.org/)</p> <p>The linked data movement began as a corollary of Berners-Lee's vision of the semantic web. Diagrams such as this one have been produced over time to illustrate the data providers which have taken on board linked data principles. Many different versions exist; this one is relatively small so an early version. It was not possible to locate it exactly.</p>
	<p>The Semantic Spider (Ensemble Project, 2009)</p> <p>Shown here is the first recorded use of a 'semantic spider' type diagram, featured in a presentation introducing the Ensemble Project to an audience of librarians.</p>

Table 1: Simple typology of the 'families' of diagrams used to represent the semantic web in presentations by the Ensemble project.

Semantic Spider – no original but part of practice

The first time the Semantic Spider made a public appearance was at a meeting with a group of librarians, which could be taken as a trial run for its intended use at a large Project Launch event taking place a day later in January 2009. It was created in order to engage a very diverse group of people, many of them potential research participants, with the work of the project. The Spider diagram was one among many conceptual tools used in this event. The noteworthy point about this diagram is that its function was to communicate 'a single organizing concept – data aggregation' and to stimulate discussion as well as envisaging the potential of these technologies as part of the participants' own contexts.

Different versions of it have since been used as part of Powerpoint presentations or in posters, on websites and in conference papers; the diagrams have been also printed out and taken along to the research settings. While our diagram tracing exercise led us to the first public appearance of the Spider, we still were not able to

say how it came to be in the first place. At one point in time an anecdote about the origins of the Spider had been circulating in the team; that the original version was 'scribble on a paper napkin at a Spanish cafe'. In order to discover more about the Spider, we interviewed each of the five core team researchers.

We first interviewed Jim, a researcher who saddles both the computer sciences and education camps in the project, and who is widely credited with creating the Semantic Spider. Rather than confirming our assumptions about an original, Jim stated:

*"I think we've got to be careful here not to sort of, erm, fall into a trap of assuming that there is some sort of grand narrative, whereby some scribble gradually became elaborated. - I think it is important to realise that sort of [researcher] and I, draw this kind of stuff *all the time*. This is just one of the things that we do while we're sitting round with a piece of paper. You know, and we draw, we've got *countless* diagrams, and scribbles, and little... flow charts." -Jim*

For Jim there does not appear to be any diagram that could be pointed out to be the very original version, the sketching of diagrams is simply part of his day to day work; it is a practice, a way of thinking. In discussing complex systems it is often easier to convey your ideas with boxes and arrows than just with words. He emphasized the communicative aspect and the temporary nature of these doodles, saying:

"you know if I could get away with gesturing, if I could get away with... if I could save myself from walking to the white board and doing it with a gesture, I'd do it with a gesture. (laughs)" -Jim

Jim further states that the diagrams are intrinsic to the discursive context within which they come to be, and that looking at them outside this context essential ideas might be missed, or misunderstood. Furthermore, the Spider diagram was created independently of the work of the project – it would help explain the semantic web, even without the work being carried out in the settings.

Amy, a computer scientist, shares Jim's views about the practice of doodling diagrams. However, she can specify a time when she first encountered the Spider – on her arrival to the project, as a doodle during her job interview with Jim. In contrast to Jim and Amy, the other core team members, primarily education researchers and social scientists, tend to recall becoming aware of the diagram through presentations:

"I remember kind of um starting to have a conversation with [Jim], and then I stopped for a bit, and I was incommunicado, and the next thing I knew there was a set of slides and with spider" – Lea

"This section came very early in the project, I think it was a talk of [Jim]" – Tom

"It was probably presented within introductory kind of talks about the Ensemble project, probably [Jim] would've presented it" – Ann

These interviews explicated the fact that the Spider diagram, while seemingly a shared object in the project discourse, is a creation of the Computer Science end of the interdisciplinary team. The social scientists/education researchers do not share the 'ownership' of the creation of the diagram; they simply acknowledge their role as part of the 'audience' it is being presented to. This relates to how stable or fluid the diagram is perceived and enacted as.

Stability and fluidity

The nature of the Spider is that it can be drawn on the fly on a white board or a piece of paper; arrows here and there might appear, or disappear, boxes added and taken off depending on who it is being discussed with and what the needs and interests of that party are. In the technologists hands the diagram is fluid and temporary, it lives according to the discursive and socio-material contexts it is being used as part of.

While Jim wishes to emphasize the fleeting and unstable nature of the Spider diagram, the rest of the team members see the Spider as a more stable object. This includes Amy, typically the other party involved in the conversations which feature diagram sketching as a 'thinking practice'. Amy had a special role working with the technologies; it was her job to determine which types of repository and triplestore the project would use. Since making these decisions, Amy sees the diagram as being stabilized:

"It has changed in the sense of now definitely we have a much clearer idea about the type of technologies we are now working with. So that's why I think - like we have like a more stable diagram, something like that, stable, yep." - Amy

In the educational researchers' use, on the other hand, the diagram becomes a static object. Ann, one of the educational researchers, explained that she never changes anything on the diagram, but now that her understanding of the technology has increased, she can see what might be missing or added in subsequent diagrams. She prints the diagram out and takes it along as a piece of paper, or pulls it up as a digital slide, which is then shown to those with whom it is being discussed.

Although the diagram might not be intended to be a permanent object, it is the act of presenting the diagram that appears to facilitate stabilization. For the purposes of engaging different audiences, ideas enacted in doodles become translated into a diagram; presenting that as part of a Powerpoint presentation, or on a poster make it appear as stable in the eyes of the audiences. Lea, a social scientist with technology expertise, but no active part in Spider's creation, characterized this as follows:

"- - it [the Spider] was created for a particular purpose in the project, which was to um, abstract the technologies - - and then, I think that it was, it became a thing in itself which was used to um, explain parts of the project, to think with parts of the project, um, to envision- - "-Lea

The Semantic Spider presented at the January event had indeed been intended to be quite a temporary thing. Quite unexpectedly for the computer scientists, the team members, most of whom are social scientists, found the diagram very useful, and soon, it was being asked to be pulled up at team meetings to help discussion around technologies. As it was being aired at various public events or conjunctions, it became a point of discussion within the team – how has the spider changed now and why? Why are we talking about the technology in these terms? There is a new arrow there, what does that mean?

While different audiences seem to prompt slight changes in the Spider – changes in number of arrows or type of boxes, or their colour - these are largely 'cosmetic' and serve the purpose of communicating a particular idea to a particular audience. In time the Semantic Spider became first translated into a html-format displayed as a webpage, and later on, into an Exhibit tool. This made it richer and more interactive – more of an object, a piece of semantic technology rather than a mere representation of it. It was at this point that Ann, an education researcher, said that 'it all clicked to place' for her in terms of understanding the technologies, as it was possible to play with the exhibit, and see how it all linked together. Since then she has taken a print out of the diagram with her to the research settings in order to explain to her research participants what kinds of data, for instance, they would need from them for this piece of technology to work.

"it's quite recently that I've actually taken to having the diagram with me when I go to interviews and stuff, um, I did it on purpose for the participatory design workshop with the Dance students, because I wanted to explain to them why we were doing the design workshop, what kind of information we wanted to get from them - -".

To sum up, for the Computer Scientists the Spider diagram is, or was initially, a temporary object, arisen out their everyday practice of diagram sketching. However, it seems to have started stabilizing in form after some core technologies were decided upon. The other team members, on the other hand, have seen it from the

beginning as a more stable thing, and used it as a more static object. Its perceived stability only grew as it was translated from a Powerpoint slide into a html- format, and further, into a piece of Semantic technology.

The multiple Semantic Spider

The doodles could be conceptualised as enactments of the technologists understanding and current thinking of the Semantic Web. However, the Spider is a deliberate simplification, a representation, of some the aspects of the technology. Jim wishes to characterise the Semantic Spider as a cartoon of the semantic web, created for a particular purpose to communicate a particular aspect of the semantic web. Both Jim and Amy say that their day-to-day doodles are far more complex than anything that finds their way to be presented in a Powerpoint. It is a language of their own in which they communicate. Due to their expertise, it is up to them to decide which aspects of the complex technology are necessary to be presented to the non-experts, be it the other team members or the external audiences. For Jim, this highlights the pedagogic nature of the Semantic Spider:

"If we were to sit down and draw 'the full unexpurgated version of the semantic spider, there would probably be a corner of it, where the arrows would be crossed out and drawn in a different position. Do you see what I mean? And that's what I mean, and it comes back to my point about it being a kind of pedagogical device. In the same way as a teacher you might... simplify a very complex area to try and get the discourse going. You know, in order to get a kind of working understanding going, you are constantly making decisions of 'how much of this do I need to tell you'." -Jim

Apart from using it as a pedagogic device, Jim and Amy also use the Spider for planning their work:

"-- we're using it as a planning tool, we're using it to plan out and map out our progress, you know, it's more useful to us than a Gantt chart, it's more useful to us than a structured text." -Jim

"it's like a way of structuring your work really, and it's quite useful because you identify like the different technologies, you make like categories there, and from the point of view of defining like a process of development I think it's it's been quite useful - - it's, like a planning tool. That's how I see it." - Amy

Other team members also characterize it as e.g. a ‘thinking tool’, ‘information tool’, or ‘tool for engaging participants’. The common thread running through all of the uses, however, is *communication*. Although there are significant differences in terms of who is communicating what to whom using the Spider, the consensus is that it is important for communication one way or another. There are cases of communication between individuals or cohorts within the team; from the team or individuals acting on behalf of the team, and practitioner participants in the research settings; and of individuals (acting on behalf of the team, or not) communicating to external audiences through seminars and the like. The Spider has taken the role of enabling communication between different groups. Lea, for instance, explained how using the Spider had helped her to discuss the developing of semantic technologies with technologists (external to our project) at her institution, while Amy had found useful for talking about the technologies within the team:

“In the [department] - - there’s techies there, who are familiar with the layer cake and ‘cos they couldn’t see that in any of the Ensemble rhetoric, -- it’s all demonstrators but none of the layer cake, then seeing the spider and having those abstractions you know - aggregation, visualization, and so on initially - and then different sorts, different kinds of data sources later on, that, um, it became a tool for conversation, a tool for thought.” –Lea

“- - before just talking about the things or showing some applications I had the impression sometimes it wasn’t enough to communicate, maybe sometimes because of the too technical language or maybe just because of like the complexity itself and ah yes and I have to say after starting using it [the Spider diagram] I was finding like I mean the process of talking to social scientists much more much more easier.” – Amy

Expertise and divergent expectations

The discussion about the origins and the fluidity or stability of the Spider diagram as well as the purposes of what it was been used for highlights several things. For example, the nature of interdisciplinary teams and of working between parties who do not share the same working practices, and the importance of communication in these. This is related to the aspect of expertise: there are those team members who are experts in technology, and who can communicate about it, and those who are learning about it. It is commonly acknowledged in the team that the computer scientists are largely in the role of the ‘teacher’ and social scientists in the role of the ‘learner’. Since the Spider was first introduced, and subsequently adopted by the team, it is possible to evidence an increasing understanding about semantic technologies on the part of those who were unfamiliar with it. Using the Spider

diagram with the research participants has enabled the researchers to discuss semantic technologies with them independently.

"We've been talking a lot about like, the actual problems about like how projects understand so far interdisciplinarity. Once we were using this diagram in this workshop we realized how even for members of the team it has been really useful to start talking to people from the settings, teachers, students. And then - - actually they I think uh in, for example in Ann's case I think in my opinion she has now got a much better understanding of how these, and she say well actually this diagram has facilitated her through the task of talking about technologies with teachers and students" – Amy

Expertise leads also to an aspect of 'ownership' of the diagram - it is seen largely as Jim's product by the rest of the team. Jim and Amy create diagrams; the others use them, and perhaps replicate them, but don't create their own – simply for the fact that they do not know the technology well enough to do that, or because that is not part of their work remit. In some instances this has led to divergent expectations of what it can or cannot do, or should be able to be used for. For example, for Lea, a social scientist with technology expertise, the Spider helped explain how other people in the project thought about the technology. While this was useful, and helped Lea understand the semantic technologies better, she was approaching the semantic technology from an application and design point of view. Her concern was with trying to get people envisaging what they wanted from the technology and about the possible data sources, which did not then exist as ready-made elements. Therefore she would have liked to be able to use the (Exhibit) Spider to *demonstrate* how the semantic technology works in practice, in order to help the parties she was working with to think about the semantic technologies. Lea goes on to add that the Spider might be better with helping potential users to understand the 'nitty-gritty' of where the data is coming from, rather than making them think about how the technology might be applied in their own settings.

"- we can only show it to people to a certain extent then they have to play with it and I must admit, um, it didn't have the same quality of discussion from using that in terms of user requirements, you know, possible applications, the analogy approach seems to work better for the people that I work with, and it did occur to me that it might be the next level, you know when you need to explain to people 'this is why we need to have access to your data' we need to work out you know, understanding how it's faceted, [unclear bit], understanding the nitty gritty of where the data is coming from and the kind of, the format it's coming in and so on." –Lea

Lea is not alone in hoping for the Spider to be used more interactively. Also Ann, when asked if there was anything she would change in the Spider, says:

"-I would, I would like to see it taken through to completion with these demonstration bits in it, 'cos it was really useful for me to see [Jim] demonstrate the online services and what they do, because I'm really not familiar with it, and so if, if there were demonstrations of um Babel conversions and and um, how that would work from an archival database type of thing, - - the diagram does help a lot with that in my thinking and understanding of it but if there were actual demonstrations, if I'd actually seen it, because I don't do the technology development and I haven't done these things, I would understand better. " -Ann

In all of the interviews there was one member, Tom, who appeared to be relatively untouched by the Spider diagram. He pertains to the 'education' part of the interdisciplinary network, but interestingly also has a background in computing. To him the idea of the semantic technology has seemed clear enough even without the diagram – it is simply about encoding heterogeneous sources into a common format. He stated that he didn't find the Spider interesting "because I know what it is about, you know". He also perceived the diagram as 'representing the technical side' of the project, leaving him and his work outside of it, as his research interests focus on pedagogy, and that was something that the diagram did not touch upon. In response to a question whether he was talking about technologies at the settings at all, he replied:

"Not really. I think what we point out is heterogeneity, which is obviously in the diagram ... and I am, I am a bit reluctant to talk about visualization and so on, because uh, uh yes that's possible and so on but then it becomes really a kind of a pedagogical question the whole thing you know, what kind of, what do you give to the students OK, because they are shielded from all that, what is going on behind the interface, yeah, so I talk little, little about technology, I think only about heterogeneity and the possibility to aggregate resources and to reuse them in some way, yeah. " -Tom

Rather than using the Spider for engaging participants or for talking about the technologies he guides the research participants into thinking what it is they would like to teach, what different types of resources to use, with a view of having these encoded in such a way that the semantic technology could read them. Therefore he did not find the Spider useful for his own purposes, nor does he engage with it beyond consuming it as a member of an audience, or as participant in discussions about it at meetings.

When thinking about the variety of uses the Spider has been put to, it is useful to consider Annemarie Mol's formulation of 'objects coming into being as enactments in practices' (2003). Rather than seeing the Spider as a singular 'thing' (which it clearly is not anyway) taking it as being enacted into being in different practices would bring forth its multiple nature: the computer scientists enact their thinking about technologies as doodles, out of which the Spider diagram is created as a

simplified version for a particular purpose. It is enacted as a communication or an instructional device with particular external audiences, but also within the team. Adopted by the Educational researchers, the Spider diagram becomes enacted as a static object, something that can be taken along and shown to people in a different location. It is being enacted as a communication tool, or a thinking tool, or a tool for envisaging possibilities, or teaching about technologies. The Computer scientists also enact it as a planning tool for their own work. It is also enacted as 'not my thing', as not useful for one's work. Through these practices, the Semantic Spider emerges as a multiple object, quoting Mol, as 'more than one, while remaining less than many'(Mol 2003, 55).

Semantic spider in negotiating boundaries?

The Semantic Spider, which has emerged as a multiple, conceptual object, was originally created to communicate aspects of the semantic web for *external* audiences. From our investigation it emerges that while doodling diagrams is part of the work practice for the computer scientists in the team, the Semantic Spider is doing some important mediating work between the two disciplinary 'camps' *within* the project. Its adoption by the team was an unexpected turn of events for the computer scientists. Could the Spider thus be conceptualized as a Boundary Object (cf. Bowker and Star, 1999)?

Star and Griesemer (1989) define boundary objects as follows:

"Boundary objects are objects which are both plastic enough to adapt to local needs and constraints of the several parties employing them, yet robust enough to maintain a common identity across sites. They are weakly structured in common use, and become strongly structured in individual-site use. They may be abstract or concrete. They have different meanings in different social worlds but their structure is common enough to more than one world to make them recognizable means of translation. The creation and management of boundary objects is key in developing and maintaining coherence across intersecting social worlds." (Star and Griesemer, 1989, p. 393)

This issue was discussed at one of the team meetings. There are several boxes that the Semantic Spider would seem to check – 'robust enough to maintain a common identity across sites'; it seems to be both 'abstract' and 'concrete'; perhaps have a different meaning in different social worlds. But more importantly, we would add, it *does* different things in the different parts of the project and for different team members. We could say that there is plasticity to the diagrams in the doodling phase, where boxes and arrows might appear and disappear, but in contrast to the Star and Griesemer definition, the diagram becomes stabilized *as* it *crosses* the internal 'boundaries' – a problematic concept, more of which below - within the team.

Another divergent point about our Spider as a boundary object is that it has not deliberately been developed to the role of a boundary object, nor is it being maintained as one – it was *adopted* as one by the team members, something the computer scientists did not anticipate. This side of the team has not had a hand in creating or maintaining it. With the differing expectations of its capacities and the varied uses it has been put to, it would be hard to characterize the Spider diagram as an overall point of convergence within the team. However, it might work as a more traditional Boundary Object *between* the Computer Scientists (cf. Beckhy 1999, quoted in Lee 2007 311). As Charlotte Lee (2007), who studied a newly established museum-design team, points out the Boundary Object concept has become overused, a ‘catch-all for several theoretical constructs’ (p.335), while especially in multi-disciplinary collaborations it is often clear that shared artifacts do not fit this description. In her study Lee proposes five different types of artifacts to critique and enhance the concept of Boundary Object, calling these *Boundary Negotiating Artifacts*. According to her, these are used to ‘record, organize, explore and share ideas; introduce concepts and techniques; create alliances; create a venue for the exchange of information, augment brokering activities; and create shared understanding about specific design problems’ (Lee 2007, 333), description which seems to articulate well with what we discovered about the use of Spider in our study. Lee’s characterization of a sub-type called *Borrowed Artifacts* resonated with our findings around the Spider:

“Borrowed artifacts that are taken from its creator in one community of practice and used in unanticipated ways by those in another community of practice. Designers use borrowed artifacts to augment their understanding of design problems. The practice of borrowing occurs when communities of practice are in close proximity.” – Lee, 2007, 331

Furthermore, according to Lee (2007), the boundary negotiating artifacts are surrounded by sets of practices that may or may not be agreed upon by participants. The computer scientists have the practice of doodling, in which the thinking about the technologies is enacted into being through doodling diagrams (cf. Mol, 2003). The presented Spider diagram was subsequently adopted by the other team members as part of their practices e.g., of making sense of the technologies, and of engaging research participants, uses not expected by the computer scientists. Lee states that the boundary negotiation artifacts are fluid – they can change from one type to another, when the context of use changes, as the Spider has done in our project. From being a ‘communication tool’ it has been adopted as a ‘tool to engage research participants’, for instance. These artifacts also facilitate the transmitting of information cross boundaries, as the Spider does, and in establishing and pushing boundaries. These artifacts can be physically incorporated or transformed into other artifacts, something the Semantic Exhibit Spider could be seen to be. Lee further writes that these boundary negotiating artifacts could be predecessors of boundary objects (Lee, 2007). Whether the Semantic Spider will ever evolve into a fully fledged boundary object remains to be seen. It would seem to fit the

description of a boundary negotiating artifact in the case of our team, but it would have to be an *internal* boundary negotiating artifact, if our team was taken as a community in itself. However, we wish to conceptualize our research team as a heterogeneous network, where drawing of both internal and external boundaries is more problematic (cf. Edwards et al., 2009). Therefore we suggest it might be better to talk about the Semantic Spider in terms of negotiating a relation between different types of work practices present in the team – and to call it a *practice negotiating artifact*.

Conclusions

In this paper we have discussed a diagram nicknamed the ‘Semantic Spider’. It has been used for depicting aspects of the Semantic Web, within and by an interdisciplinary research and development project Ensemble, whose members could be crudely divided into ‘Computer Scientists’ and ‘Educational Researchers’. This object emerged as a point of interest due to the apparent changes in its appearance and its varied use by the team members.

The paper is entitled the ‘Phases and Faces of the Semantic Spider’, and as yet, we have not explicitly touched upon either. Rather, the title shows what our preliminary assumptions of this object were – that there would be a linear path of development through phases, and that the Spider object would show a different ‘face’ depending on the audience, or perhaps its phase of development. Rather than discovering any linear evolutionary phases, we discovered first of all a practice of doodling - the Computer Scientists daily practice of creating prolific numbers of diagrams. It is out of this that the Semantic Spider, a purposefully simplified version of these diagrams depicting the complex and heterogeneous semantic web, first emerged. Characterized as a cartoon by its creators, it was originally created to help communicate a single concept of data aggregation to a diverse audience, and in order to engage them in the work of the team. Different versions of the Spider have since been used in this manner at a number of conjunctions. Rather than talking about different ‘faces’ then, it would be more accurate to talk about ‘masks’ of the Semantic Spider, due to its nature as a simplified representation of a more complex system – the system itself was not necessarily changing, only its representation.

We further discovered that the Computer Scientists had not intended for the Spider diagram to become a permanent object, but to their surprise the team members found it very useful in discussing the semantic web, too, and it gradually became adopted as a tool for that purpose. As the team members learned more about the semantic web, some of them started using a version of the diagram in their own work, as a static object. They used it as a tool for talking to their research participants, other professionals or in conversations between the social scientists and computer scientists. This, as well as its repeated appearances as part of presentations further stabilized its standing within the team. The differences in

enacting the Spider – either as a temporary or a stable thing also relates to expertise. Those who are conversant with the technology can sketch diagrams in order to communicate aspects of the semantic web the way they see best – others can learn from them, and use their drawings as static tools, but not create originals. The Spider emerges from our investigations as a multiple object, depending on whose practice it is being enacted into being as part of.

The main asset of the Semantic Spider seemed to be its capacity to help in communicating ideas of the semantic web between different communities. We argue that the Spider could be usefully conceptualized as *practice negotiating artifact*, drawing upon the concept of *boundary negotiating artifact* by Lee (2007), as it has been borrowed from one part of a heterogeneous network to another, put to unexpected uses, and because it helps to communicate ideas from one network of practices to another.

While we found the diagram, its uses and the changes it had gone through interesting enough to want to study it more closely, the work the Spider did for *us* in this research was quite unexpected. We were not prepared to the multiplicities and differences of opinion that examining the Spider would unearth. It has helped us get a better view of the different working practices across the core team, highlight aspects of interdisciplinary working, communication, differences in skill and expertise but also the further blurring of disciplinary boundaries in the interdisciplinary team.

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